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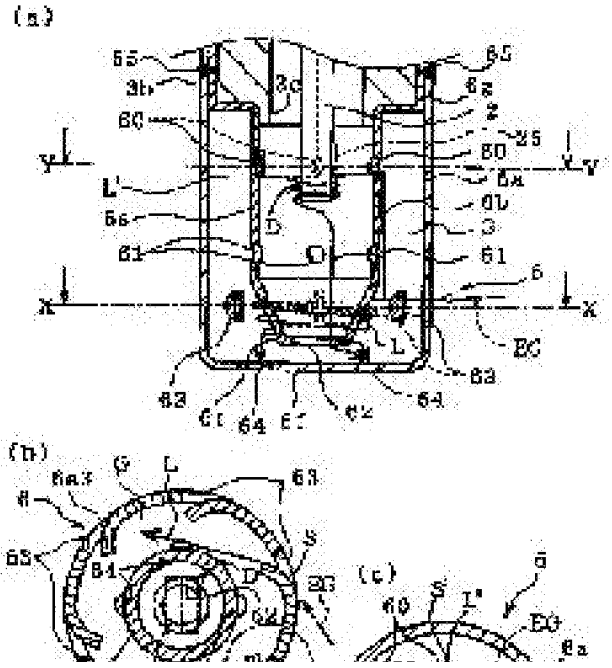
(54) GAS SENSOR

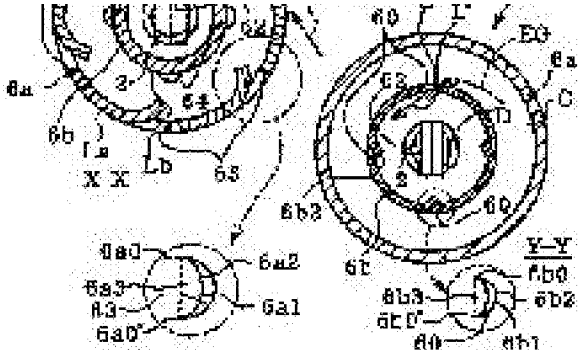
(57)Abstract:

PROBLEM TO BE SOLVED: To provide a gas sensor in which a protecting function for a detecting part which is naturally provided in a multiple structural protector is enhanced.

SOLUTION: A protector 6 is constructed at least in a double structure with an inner first cylindrical part 6b and an outer second cylindrical part 6a. Guide bodies 6a3 are disposed to second side gas inlets 63 formed to a side wall part of the second cylindrical part 6a. The guide bodies 6a3 have a function of generating a circular flow of a gas EG to be measured to surround an outer face of a side wall part of the first cylindrical part 6b. A



centrifugal force generated in association with the circular flow separates relatively heavy water drops, oil drops or the like from a relatively light gas component and presses the drops or the like to an inner face of the side wall part of the second cylindrical part 6a. Even when water drops, oil drops or the like are included in the gas EG to be measured, the water drops, oil drops or the like become hard to invade the interior (a detecting part D) of the first cylindrical part 6b.



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[Claim(s)]
[Claim 1] A wrap protector the primary detecting element formed in the front end side of a detection element The first tubed part, While equipping the outside of this first tubed part with the second tubed part arranged in the shape of the abbreviation same axle and forming two or more first side gas inlets in the side wall part of said first tubed part along the direction of a circumference The gas sensor characterized by having arranged the guide object for generating the revolution style which the second side gas inlet is formed in the side wall part of said second tubed part, and introduces gas under test into this second side gas inlet between said first tubed part and said second tubed part, and encloses the side wall outside side of said first tubed part.
[Claim 2] Said guide object is a gas sensor according to claim 1 which has extended in one towards the radial-direction inner side from the side wall part of said second tubed part.
[Claim 3] Said guide object is a gas sensor according to claim 1 or 2 which consists of bending the claw-like part which creates the curved break in the side wall part of said second tubed part, and is produced by this break to a radial-direction inner side.
[Claim 4] Said first side gas inlet is a gas sensor according to claim 1 to 3 arranged rather than said second side gas inlet at the axial direction back end side.
[Claim 5] The gas sensor according to claim 1 to 4 to which the extension (henceforth gas leading in wire) to said under-test gas introduction direction of the gas introduction side of said guide object is estranged and located in a radial-direction outside rather than the side wall outside side of said first tubed part in the axial rectangular cross section including said second side gas inlet.
[Claim 6] The gas sensor according to claim 5 by which the side wall part by the side of the front end of said first tubed part is formed in the diameter reduction part from which it becomes a byway as the axial direction front end side so that said gas leading in wire may be estranged and located in a radial-direction outside rather than the side wall outside side of said first tubed part in the axial rectangular cross section including said second side gas inlet.
[Claim 7] The gas sensor according to claim 1 to 6 by which the first side gas outlet is formed in the front end side of said first tubed part while the diameter reduction part from which it becomes a byway as the axial direction front end side is formed in the side wall part by the side of the front end of said first tubed part.
[Claim 8] Said second side gas inlet is a gas sensor according to claim 7 arranged in said diameter reduction part of said first tubed part, and the position which counters.

[Claim 9] Said second side gas inlet is a gas sensor according to claim 7 arranged in the position of axial direction front end slippage rather than the front end of said diameter reduction part of said first tubed part.
[Claim 10] The gas sensor according to claim 1 to 9 by which the second side gas outlet is formed in the front end side of said second tubed part.
[Claim 11] It is the gas sensor according to claim 10 which estranges said second side gas outlet of said second tubed part to a radial direction in an axial rectangular cross section to the first side gas outlet formed in the front end side of said first tubed part, and is located.

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the gas sensor for detecting the ingredient in the gas used as a measuring object, such as an oxygen sensor, HC sensor, and an NOx sensor, being detected.
[0002]
[Description of the Prior Art] The thing of the structure which has arranged the rod form or tubed detection element by which the primary detecting element which detects an ingredient to be detected was formed in the front end as above gas sensors inside metal casings is known. In such a gas sensor, the primary detecting element located in measurement atmosphere is prepared in the wrap protector. A gas stream through-hole is formed in the side wall part of a protector, and gas under test, such as exhaust gas, is drawn in a protector from this gas stream through-hole, and is contacted to a primary detecting element.
[0003] In the various gas sensors for cars, [these days] In order to raise the protection function of a primary detecting element to invasion of the condensed water further condensed to waterdrop, an oil droplet, or dirt in gas under test etc. in the wall surface and interior space of the protector, many things which made this protector the dual structure which consists of a tubed part of two inside and outside are also used. As shown in drawing 10 , conventionally, it sets to the protector 106 of such dual structure. Forming the gas inlet 163,161 in the side wall part of the internal and external tubed parts 106a and 106b, respectively, gas under test passes along the gas inlet 163 of the outside tubed part 106a first, and serves as a form which subsequently reaches a primary detecting element 102 through the gas inlet 161 of the inside tubed part 106b.
[0004]
[Problem to be solved by the invention] By the way, in the protector of the above dual structure, although the protection function of a primary detecting element is raised, resistance of as opposed to gas stream ** only in the part which becomes double [a wall] increases, for example, the exchange speed of the gas under test between a protector outside and protector interior space also becomes small in many cases. Therefore, when the concentration of the ingredient under test in measurement atmosphere changes rapidly, there is a problem of the structure of being easy to come to a response out of delay.
[0005] Furthermore, if the gas detection side DP is formed only especially in one field of a layered product in the primary detecting element 102 in this case like drawing 10 , the following problems will arise. Namely, [when gas EG under test, such as exhaust gas, flows in in a protector 106 from the gas detection side DP side, in order that a gas stream may arrive at the gas detection side DP easily

comparatively directly, become comparatively good / a detection response when the concentration of the ingredient in gas to be detected etc. changes /, but] For example, when it flows in from this and the opposite side, since a gas stream is equivalent to the field of the opposite side, the detection side DP of a primary detecting element 102 becomes easy to produce a detection response delay. Thus, there is a fault (direction dependency) from which the response and output characteristic of a sensor change easily according to the direction of the gas stream under test over a protector.

[0006] In addition, since single structure, then the exchange speed of the gas of protector inside and outside are raised in a protector, it becomes good [the response of a sensor], but the protection function to a primary detecting element worsens with a natural thing. Moreover, the problem on which the temperature of a primary detecting element will fall if a gas flow rate becomes large rapidly or gas ** falls, for example, an oxygen concentration cell element inactivates, detection sensitivity falls to or a detection output breaks off is produced. in addition -- although there is also the method of enlarging the size of the gas inlet of the protector of dual structure in order to raise the exchange speed of gas -- this case -- the difference of a grade -- that -- it was difficult to be hard to avoid the same problem as the above-mentioned single structure protector, and to reconcile a response and a protection function.

[0007] There is a technical problem of this invention in offering the gas sensor from which a uniform response or a uniform output characteristic is obtained on a suitable level that the protection function of the primary detecting element which a multiplet structure protector possesses essentially is raised further, and it is [as a result] moreover hard to produce the direction dependency of a gas stream under test in a sensor response characteristic.

[0008]

[Means for Solving the Problem and its Function and Effect] In order to solve the above-mentioned technical problem, [the gas sensor of this invention] A wrap protector the primary detecting element formed in the front end side of a detection element The first tubed part, While equipping the outside of this first tubed part with the second tubed part arranged in the shape of the abbreviation same axle and forming two or more first side gas inlets in the side wall part of said first tubed part along the direction of a circumference It is characterized by having arranged the guide object for generating the revolution style which the second side gas inlet is formed in the side wall part of said second tubed part, and introduces gas under test into this second side gas inlet between said first tubed part and said second tubed part, and encloses the side wall outside side of said first tubed part.

[0009] In the gas sensor of above-mentioned this invention, the guide object is arranged in the second side gas inlet where the protector has the first inside tubed part and the second outside tubed part and which is made into dual structure at least, and is formed in the side wall part of the second tubed part. This guide object has the function to produce a revolution style in the state of surrounding the side wall outside side of the first tubed part for gas under test, relatively, the centrifugal force generated in connection with this revolution style dissociates with a part for light gas relatively, and heavy waterdrop, oil droplet, etc. are forced on the side wall circles side of the second tubed part. Therefore, also when waterdrop, an oil droplet, etc. are contained in gas under test, the first tubed part inner-side(primary detecting element)-passes, these waterdrop, an oil droplet, etc. become difficult to invade, and the protection function to a primary detecting element improves further.

[0010] Gas under test will flow inside the first tubed part from each first side gas inlet formed in the side wall part of the first tubed part along the direction of a circumference, forming a revolution style in the state of surrounding the side wall outside side of the first tubed part with the guide object of the second

side gas inlet. [two or more] As a result, no matter a gas stream under test may hit the circumference of the shaft line of a protector at what angle, it does not depend in the direction of a gas stream under test, but a uniform response or a uniform output is obtained. Especially to the peripheral face of a primary detecting element, this works as an advantageous effect especially, when the gas detection side is formed along the partial section of the direction of a circumference, or when the gas detection side is formed in one side with tabular.

[0011] As for a guide object, it is desirable to have extended in one towards a radial-direction inner side from the side wall part of the second tubed part here. Since the waterdrop, the oil droplet, etc. in gas under test cannot invade into a protector inner side easily and it becomes difficult to check circulation of gas under test by composition of this guide object, the protection function and sensor response characteristic over a primary detecting element improve further. As such a guide object, in the side wall part of the second tubed part, the curved break is created and the claw-like part produced by this break can consist of bending to a radial-direction inner side.

[0012] Furthermore, in this invention, the first side gas inlet can be arranged to the axial direction back end side rather than the second side gas inlet. Thus, since the first side gas inlet and the second side gas inlet are estranged and formed in the axial direction The condensed water which the waterdrop, the oil droplet, etc. in gas under test become difficult to invade into the first tubed part inner side, and is generated inside the second tubed part becomes difficult to flow inside the first tubed part (primary detecting element), has in it, and the protection function to a primary detecting element improves further.

[0013] Moreover, it is good to estrange and locate the extension (henceforth gas leading in wire) to the under-test gas introduction direction of the gas introduction side of a guide object in a radial-direction outside rather than the side wall outside side of the first tubed part in this invention in the axial rectangular cross section including the second side gas inlet. That is, since gas leading in wire touches the side wall outside side of the first tubed part or does not cross Relatively, heavy waterdrop, oil droplet, etc. are forced on the side wall circles side of the second tubed part by the centrifugal force generated in connection with a revolution style, and flows down over a wall surface by it. On the other hand, relatively [the remainder], it dissociates in waterdrop, an oil droplet, etc., and a part for light gas is introduced in the inner side (primary detecting element) of the first tubed part (centrifugal separation operation), and can prevent effectively invasion to insides of the first tubed part, such as waterdrop, an oil droplet, etc. in gas under test. Moreover, since gas leading in wire touches the side wall outside side of the first tubed part or does not cross, it is hard to condense moisture in gas under test on the side wall outside surface of the first tubed part, and invasion to the inside of the first tubed part of condensed water can be prevented. The protection function to a primary detecting element is strengthened by these the operations of many.

[0014] The gas leading in wire of this invention is specified in the axial rectangular cross section including the second side gas inlet as an extension to the under-test gas introduction direction of the gas introduction side of a guide object. Here, when the gas introduction side of a guide object consists of single planes (it is a single straight line in an axial rectangular cross section), gas leading in wire is defined uniquely. On the other hand, when the gas introduction side of a guide object consists of two or more planes or single or multiple curved surfaces, gas leading in wire may not be defined uniquely and can choose various modes of expression in this invention. Here, the comparatively general following 2 methods as a mode of expression of gas leading in wire were illustrated.

(1) Gas leading in wire is expressed with the tangent in the tip of the gas introduction side of a guide object in the axial rectangular cross section including the second side gas inlet.
(2) Gas leading in wire is expressed with the straight line which connects the point that the base of the gas introduction side of a guide object touches the side wall outside side of the second tubed part, and the tip of a gas introduction side in the axial rectangular cross section including the second side gas inlet.
[0015] Moreover, in the axial rectangular cross section including the second side gas inlet, this invention can form the side wall part by the side of the front end of the first tubed part in the diameter reduction part from which it becomes a byway as the axial direction front end side so that gas leading in wire may be estranged and located in a radial-direction outside rather than the side wall outside side of the first tubed part. Since the large opening width of the second side gas inlet until gas leading in wire touches the side wall outside side of the first tubed part by forming in a diameter reduction part the front end side of the first tubed part which counters the second side gas inlet can be taken and exchange speed (turn volume) of gas under test can be enlarged, a sensor response characteristic is improvable.
[0016] Next, while the diameter reduction part from which it becomes a byway as the axial direction front end side is formed in the side wall part by the side of the front end of the first tubed part of this invention, the first side gas outlet can be formed in the front end side of the first tubed part. [a gas stream under test enclosing the side wall outside side of the first tubed part, and circling / a diameter reduction part] by flowing toward the axial direction front end side Since negative pressure arises in the first side gas outlet side, the inside of the first tubed part will be in a decompression state and gas under test is promptly inhaled from the first side gas inlet, sufficient response is securable in spite of a multiplet structure protector.
[0017] In addition, when a "diameter reduction part" cuts the first tubed part in this invention at the plane containing a shaft line, the section of the diameter reduction part may be formed in straight shape, and may be formed in outwardness or the curved surface shape for inner.
[0018] Specifically, the first tubed part can be constituted as that by which the truncated cone form diameter reduction part was united with the tip side of a cylindrical main part part. For example, when the full length of the first tubed part is specified, it becomes possible to set easily the angle of gradient of a diameter reduction outside side as a value convenient although the first side gas outlet is made to produce negative pressure, for example by adjusting the length of the cylindrical main part part formed in the back end side.
[0019] And the second side gas inlet of this invention can be arranged in the diameter reduction part of the first tubed part, and the position which counters. In the side wall part of the second tubed part, the second side gas inlet is formed in the position which counters a diameter reduction part, and while the gas under test which flows from the second side gas inlet encloses the side wall outside side of a diameter reduction part and circles, it flows toward the axial direction front end side. With this composition, since the flow velocity of the gas under test which flows toward the axial direction front end side is raised while the second side gas inlet and a diameter reduction part counter, are arranged, enclose a diameter reduction part and circle, the negative pressure produced in the first side gas outlet side can be enlarged more. As a result, the inhalation speed of the gas under test from the first side gas inlet, as a result the exchange speed of the gas under test in the first tubed part improve, and a detection response or the output flattery nature to a concentration change becomes much more good.
[0020] In addition, the second side gas inlet of this invention may be arranged rather than the front end of the diameter reduction part of the first tubed part in the position of axial direction front end slippage.

In this case, it sets in the axial rectangular cross section including the second side gas inlet. Since the first tubed part (diameter reduction part) corresponding to the second side gas inlet stops existing, the opening width of the second side gas inlet can be set up widely, the exchange speed (turn volume) of gas under test can be increased, and it becomes possible to improve a sensor response characteristic sharply.
[0021] Furthermore, when forming the second side gas outlet in the front end side of the second tubed part of this invention, the gas stream under test which flows toward the axial direction front end side can be smoothly discharged from the second side gas outlet, surrounding the side wall outside side of the first tubed part, and circling, and the stable sensor response characteristic is secured.
[0022] Moreover, in an axial rectangular cross section, the second side gas outlet of the second tubed part of this invention can be estranged and located in a radial direction to the first side gas outlet formed in the front end side of the first tubed part. Since the first side gas outlet has not overlapped with the second side gas outlet in the axial rectangular cross section even when the waterdrop, the oil droplet, etc. in gas under test invade from the second side gas outlet temporarily, there are few possibilities of invading into an internal primary detecting element further through the first side gas outlet, and the protection function to a primary detecting element is exhibited.
[0023]
[Mode for carrying out the invention] The form of operation of this invention is hereafter explained with reference to the work example shown in Drawings. The oxygen sensor 1 which detects the oxygen concentration in exhaust gas, such as a car, is shown in drawing 1 as one work example of the gas sensor of this invention. The common name of this oxygen sensor is carried out to lambda type oxygen sensor, and it has the structure where the long and slender tabular ceramic device 2 (detection element) was fixed to the subject metal fittings 3. And it is exposed to the hot exhaust gas EG as gas under test which was formed in the peripheral face of these subject metal fittings 3 and which is attached so that it may attach and the primary detecting element D by the side of the front end may be located in an exhaust pipe by a thread part 3a, and flows through the inside of this exhaust pipe. In addition, as for this Description, in the direction of a shaft line of the subject metal fittings 3, "a front side (or the front end side)" explains the projection side of a primary detecting element D by carrying out the opposite side to this "the back side (or back end side)."
[0024] The ceramic device 2 has an axial rectangle-like section, and as shown in drawing 2 (a), it is constituted as that by which the oxygen concentration cell element 21 formed in oblong tabular, respectively and the heater 22 which heats this oxygen concentration cell element 21 to a predetermined activation temperature were laminated. In addition, the oxygen concentration cell element 21 is constituted by the oxygen ion conductivity solid electrolyte which makes zirconia etc. a subject. On the other hand, the heater 22 consists of well-known ceramic heaters.
[0025] In the oxygen concentration cell element 21, the electrode lead parts 25a and 26a prolonged towards the attachment end face side of the oxygen sensor 1 along with the longitudinal direction are united with the porous electrodes 25 and 26, respectively. Among these, as for the electrode lead part 25a from a heater 22 and the electrode 25 of the side which does not counter, the end is used as an electrode terminal part 7. On the other hand, the electrode lead part 26a of the electrode 26 of the side which counters a heater 22 is connected with the electrode terminal part 7 formed in the element side of the opposite side with the beer 26b which crosses the oxygen concentration cell element 21 in the thickness direction, as shown in drawing 2 (c). That is, the oxygen concentration cell element 21 serves as the form where the electrode terminal part 7 of both the porous electrodes 25 and 26 is formed along

with the plate surface end by the side of an electrode 25. Each above-mentioned electrode, an electrode terminal part, and beer carry out pattern formation of Pt or the Pt alloy by screen-stencil etc. using the paste of metal powder with the catalytic activity of the oxygen molecule dissociative reaction, and are obtained by calcinating this.

[0026] On the other hand, the lead parts 23a and 23a for energizing to the resistance heating element pattern 23 of a heater 22 are also connected to the electrode terminal parts 7 and 7 formed in the oxygen concentration cell element 21 of a heater 22, and the plate surface end of the side which does not counter through Beer 23b, respectively, as shown in drawing 2 (d). the oxygen concentration cell element 21 and a heater 22 are shown in drawing 2 (b) -- as -- ZrO -- it is mutually joined through the ceramic layers 27, such as ceramics or Al2O3 system ceramics, 2 system. And the oxygen concentration cell element 21 serves as the detection side electrode with which the porous electrode 25 of the opposite side contacts exhaust gas while the porous electrode 26 by the side of junction (oxygen standard side porous electrode) functions as an oxygen reference electrode by impression of minute pumping current, and the surface turns into a gas detection side.

[0027] It returns to drawing 1 , and the ceramic device 2 is inserted in the insertion hole 30 of the insulator 4 arranged inside the subject metal fittings 3, and after the primary detecting element D by the side of the front end has projected from the front end of the subject metal fittings 3 fixed to an exhaust pipe, it is fixed in an insulator 4. In the direction of a shaft line, one end is open for free passage to the back end of an insertion hole 30, and while the other end carries out an opening to the back end side of an insulator 4, the opening part 31 of the diameter of a large is formed in the insulator 4 for the axial section rather than this insertion hole 30. And it is sealed by the sealing material layer 32 constituted by the subject in glass (for example, crystallization zinc silica boric acid system glass) between the inside of the opening part 31, and the external surface of the ceramic device 2.

[0028] Between an insulator 4 and the subject metal fittings 3, it adjoins in the direction of a shaft line, the talc ring 36 and the caulking ring 37 are inserted in, and an insulator 4 and the subject metal fittings 3 are being fixed to the insulator 4 side by caulking ****** through the caulking ring 37 in the back end side perimeter part of the subject metal fittings 3.

[0029] moreover -- the ceramic separator 16 and a grommet 15 being inserted in the back end circles side of an outer case 18, and following these -- the -- the connector area 13 is further formed in the inner direction side. The back end side of the lead 14 penetrated the ceramic separator 16, and is prolonged outside. On the other hand, the front end side of the lead 14 is electrically connected to each electrode terminal part 7 (four poles are named generically) of the ceramic device 2 shown in drawing 2 through the connector area 13.

[0030] The projection portion D of the ceramic device 2, i.e., a primary detecting element, is attached to the wrap protector 6 by the front end of the subject metal fittings 3. This protector 6 has the first inside tubed part 6b and the second outside tubed part 6a, and has the dual structure arranged in the shape of the abbreviation same axle. As shown in drawing 3 , the first tubed part 6b is formed in tubed [which encloses a primary detecting element D in the circumference of the shaft line of the detection element 2]. While two or more first gas inlets 60 and 61 are formed in an axial direction at a predetermined interval at the side wall part, 6t of tapered shape diameter reduction parts are formed in the axial direction front end side of this side wall part, and the first gas outlet 62 is formed in the front end side central part which is 6t of the diameter reduction part. Specifically, 6t of diameter reduction parts are formed in the front end side of 6s of cylindrical main part parts in one at truncated cone form. And the

first gas inlet 60 and 61 contains two or more sets of groups (60 and 61) of the hole mostly located in a line at equal intervals along the direction of a circumference of 6s of main part parts. In this example, the group 60 of the hole by the side of the back containing four holes in which the below-mentioned first side claw-like part six b3 was formed, and two rows of groups 61 of the hole by the side of the front containing four holes of a circle-like opening form are formed in the direction of a shaft line of 6s of main part parts.

[0031] Moreover, nothing and its front end are located in the front side rather than the front end of the first tubed part 6b in the tubed form arranged in the form where the second tubed part 6a forms the crevice G between the specified quantity between this first tubed part 6b on the outside of the first tubed part 6b. The second side gas outlet [two or more (this example four pieces)] 64 arranged at equal intervals is formed on the predetermined pitch circle in the front end side of the second tubed part 6a. Each of this second side gas outlet 64 is mutually estranged and located in a radial direction in an axial rectangular cross section in the first side gas outlet 62 formed in the front end side central part of the first tubed part 6b. By arranging the first side gas outlet 62 and the second side gas outlet 64 in this way A possibility that the waterdrop, the oil droplet, etc. in the gas EG under test which invaded from the second side gas outlet 64 may invade into the internal primary detecting element D through the first side gas outlet 62 decreases without interfering with discharge of the gas EG under test from the first side gas outlet 62 formed in the central part.

[0032] furthermore, the position corresponding to 6t of diameter reduction parts by which, as for the second tubed part 6a, 6f of bottoms are formed in the front end and which are formed cylindrical, are the side wall part front end slippage, and constitute the first tubed part 6b -- ****** -- two or more (this example six pieces) second side gas inlets 63 are formed mostly at equal intervals. The second side gas inlet 63 is in the physical relationship which does not face each other to any with the first side gas inlets 60 and 61 here. Thereby, it is prevented that gas EG under test flows into the first side gas inlets 60 and 61 directly by the second tubed part 6a.

[0033] In addition, the thing by the side of the front (61) is the direction front end side of a shaft line from a primary detecting element D among the groups 60 and 61 of the hole of two rows which forms the first side gas inlet, and it is located in the direction back end side of a shaft line rather than the second side gas inlet 63, and the thing by the side of back (60) is located with a form which encloses a primary detecting element D. By the way, in the style of [EG] exhaust gas, poison, such as phosphorus besides the waterdrop of condensed water, sulfur, and silicon, may be contained. [however, the thing which enters from a hole line 61 even if such an exhaust gas style EG may enter in the first tubed part 6b through a hole line 60 or 61] The probability which rides on a gas stream then and is discharged from the first side gas outlet 62 is high, waterdrop and poison will be distributed and the protection function of a primary detecting element D can be raised now.

[0034] Next, as shown in drawing 1 , rather than the fixing screw part 3a of the subject metal fittings 3, the diameter of the front end side is reduced for a while, and the narrow diameter portion 3b is formed. And the tubed positioning projection part 3c which projects from the opening periphery part is formed in the front end side of the narrow diameter portion 3b like drawing 3 . 6g of diameter expansion parts formed in the opening side are inserted in the outside of the narrow diameter portion 3b of the subject metal fittings 3, the first tubed part 6b being positioned by the positioning projection part 3c. On the other hand, the second tubed part 6a is inserted in the narrow diameter portion 3b of the subject metal fittings 3 in the back end side opening from the outside of 6g of diameter expansion parts of the first

tubed part 6b. It is fixed to a narrow diameter portion 3b with 6g of diameter expansion parts by the weld zone 65 (for example, the spot welding part formed intermittently or continuation laser welding part formed annularly) of the direction of a circumference.

[0035] The oxygen sensor 1 is fixed to the exhaust pipe of vehicles in the captive screw part 3a. If the primary detecting element D is exposed to the exhaust gas EG, the porous electrode 25 (drawing 2) of the oxygen concentration cell element 21 will contact the exhaust gas EG, and the oxygen concentration cell electromotive force according to the oxygen concentration in this exhaust gas EG will arise for the oxygen concentration cell element 21. This electromotive force is taken out as a sensor output. Since the protector 6 is made into double structure as mentioned above, it is excellent in the protection function to a primary detecting element D.

[0036] Form which returned to drawing 3 again and curved in the side wall part of the second tubed part 6a (after extending from one end face part six a0 and turning by the directional change part six a1) [the break (the second side break) six a2 of form which results to end face part 6a0' of another side] It creates by cutter cutting and metallic mold ******, the second side claw-like part six a3 (claw-like part) produced by this break six a2 is bent to a radial-direction inner side, and the second side gas inlet 63 is formed in the side wall part of the second tubed part nothing and simultaneous with a guide object. In the included axial rectangular cross section (drawing 3 (b)), the second side gas inlet 63 [the gas introduction side S of the second side claw-like part six a3] It consists of curved surfaces of a convex form toward the opening of the second side gas inlet 63, and gas leading in wire L is estranged and located in a radial-direction outside rather than the side wall outside side (side wall outside type line) Lb of the first tubed part 6b.

[0037] Form which curved also in the side wall part of the first tubed part 6b on the other hand (after extending from one end face part six b0 and turning by the directional change part six b1) The break (the first side break) six b2 of form which results to end face part 6b0' of another side is created by cutter cutting and metallic mold ******, the first side claw-like part six b3 produced by this first side break six b2 is bent to a radial-direction inner side, and the group 60 of the hole by the side of back is formed among the first side gas inlets 60 and 61. In the axial rectangular cross section (drawing 3 (c)) including the first side gas inlet 60, gas introduction side S' of the first side claw-like part six b3 consists of curved surfaces of a convex form toward the opening of the first side gas inlet 60, and gas leading-in-wire L' is estranged and located in a radial-direction outside rather than the side wall outside side of a primary detecting element D.

[0038] Here, reference is made about the flow of the exhaust gas EG within a protector 6. The exhaust gas EG introduced in the protector 6 from the second side gas inlet 63 flows out of the second side gas outlet 64, after flowing towards the front end side over the external surface of 6t of diameter reduction parts of the first tubed part 6b from the back end side. For this reason, since the flow velocity of the gas in alignment with 6t of diameter reduction parts is raised, the negative pressure produced in the first side gas outlet 62 can be enlarged more. As a result, the inhalation speed of the exhaust gas EG from the first side gas inlets 60 and 61, as a result the exchange speed of the exhaust gas EG in the first tubed part 6b improve, and a detection response or the output flattery nature to a concentration change becomes much more good. Moreover, a revolution style will be produced by the second side claw-like part six a3, this revolution style will flow so that 6t of diameter reduction parts of the first tubed part 6b may be surrounded, and the exhaust gas style EG introduced from the second side gas inlet 63 will flow out of the second side gas outlet 64. By generating of this revolution style, waterdrop, an oil droplet, etc.

become difficult to invade into a first tubed part 6b inner side, and it excels in the protection function to a primary detecting element D.

[0039] The inside of the first tubed part 6b is attracted by the negative pressure produced in the first side gas outlet 62, at this time, the exhaust gas EG serves as a revolution style in alignment with the side wall part of the first tubed part 6b by the first side claw-like part six b3, and abbreviation etc. is inhaled in direction. As a result, the revolution style of the uniform exhaust gas EG is generated so that a primary detecting element D may be surrounded in the circumference of the shaft line of a protector 6, and a uniform response or a uniform output is obtained. Moreover, since the first side claw-like parts six b3 overlap in the shape of a flap to the first side gas inlet 60, waterdrop, an oil droplet, etc. cannot invade into a first tubed part 6b inner side easily. Furthermore, by the revolution style which encloses a primary detecting element D, also when waterdrop, an oil droplet, etc. invade into a first tubed part 6b inner side, it becomes difficult to contact a primary detecting element D directly, and excels in the protection function to a primary detecting element D.

[0040] Since the exhaust gas EG is supplied [abbreviation] in direction to a primary detecting element D no matter the exhaust gas style EG may hit the circumference of the shaft line of a protector 6 at what angle, as a result of forming such an exhaust gas style EG, it does not depend in the direction of the exhaust gas style EG, but a uniform response or a uniform output characteristic is obtained. [with moreover, the exhaust gas EG inhaled from the first side gas inlets 60 and 61 because the first side gas outlet 62 serves as negative pressure] Since the comparatively big exhaust gas style EG can be formed along the surface (gas detection side) of the detection side porous electrode 25, even when changing to lean atmosphere from rich atmosphere, good output flattery nature is obtained.

[0041] In addition, the second side or the first side break six a2, and the form of six b2 can be suitably changed into the shape of a U character, a U shape, etc. Moreover, it can change about these breaks six a2, the number of six b2, a position, the bending direction of a bend line, etc. Furthermore, in addition to the hole 60 of the group arranged with the form which counters a primary detecting element D among the first side gas inlets 60 and 61, the first side claw-like part six b3 may be replaced with the hole 60, and may be formed in the hole 61 of the group located in the direction front end side of a shaft line rather than the front end of a primary detecting element D.

[0042] Here, drawing 4 which is the enlarged drawing of drawing 3 (b) explains the gas introduction side S and the gas leading in wire L of a guide object (the second side claw-like part six a3). in this Description -- gas leading in wire L -- "-- the axial rectangular cross section including the second side gas inlet 63 is defined as extension" to the exhaust gas EG (gas under test) introduction direction of the gas introduction side S of the second side claw-like part six a3 (guide object). By the way, this gas leading in wire L can be put in another way as "the locus which the exhaust gas EG which flows along the gas introduction side S of the second side claw-like part six a3 through the second side gas inlet 63 between the first tubed part 6b and the second tubed part 6a draws in the axial rectangular cross section including the second side gas inlet 63."

[0043] And in drawing 4 , gas leading in wire L is expressed by the following two methods.

(1) Gas leading in wire L is expressed with the tangent L1 (henceforth a tangent L1) in the tip P1 of the gas introduction side S of the second side claw-like part six a3 in the axial rectangular cross section including the second side gas inlet 63.

(2) Gas leading in wire L is expressed with the straight line L2 (henceforth a straight line L2) which connects the point P2 that the base of the gas introduction side S of the second side claw-like part six a3

touches the side wall outside side La of the second tubed part 6a, and the tip P1 of the gas introduction side S in the axial rectangular cross section including the second side gas inlet 63.

[0044] [since the gas introduction side S of the second side claw-like part six a3 consists of two or more curved surfaces at drawing 4 , are expressed with a different line from a tangent L1 and a straight line L2, but] When the gas introduction side S of the second side claw-like part six a3 consists of single planes (straight line single on an axial rectangular cross sectional view) temporarily, a tangent L1 and a straight line L2 will be in agreement on drawing 4 . Generally, a straight line L2 is that which is expressed as an average of the direction line of an entrance of the exhaust gas EG, and the direction line of an exit (the direction line of an exit of these corresponds to a tangent L1), and [a straight line L2] Compared with a tangent L1, rather than the side wall outside side Lb of the first tubed part 6b, it estranges outside that of a radial direction and is located in many cases (getting it blocked and approaching according to the side wall circles side of the second tubed part 6a).

[0045] Anyway, gas leading in wire L (a tangent L1 or straight line L2) is estranged and located in a radial-direction outside rather than the side wall outside side Lb of the first tubed part 6b as seen to drawing 4 . This has achieved the following functions. Namely, since gas leading in wire L (a tangent L1 or straight line L2) touches the side wall outside side Lb of the first tubed part 6b or does not cross [with the centrifugal force generated in connection with the revolution style which encloses the side wall outside side of the first tubed part 6b] Relatively, heavy waterdrop, oil droplet, etc. are forced on the side wall circles side of the second tubed part 6a, and WD flows down it over a wall surface. On the other hand, relatively [the remainder], it dissociates in WD, waterdrop, an oil droplet, etc. are introduced in the inner side (primary detecting element D) of the first tubed part 6b (centrifugal separation operation), and the amount of light gas can prevent effectively invasion to protector 6 inside of WD(s), such as waterdrop, an oil droplet, etc. in the exhaust gas EG. Moreover, since gas leading in wire L (a tangent L1 or straight line L2) touches the side wall outside side Lb of the first tubed part 6b or does not cross, it is hard to condense moisture in the exhaust gas EG on the side wall outside surface of the first tubed part 6b, and invasion to protector 6 inside of condensed water can be prevented. The protection function to a primary detecting element D is strengthened by these the operations of many.

[0046] To drawing 5 , the axial rectangular cross section form of a guide object (the second side claw-like part six a3) is illustrated. When the gas introduction side S of the second side claw-like part six a3 consists of single planes (straight line single on an axial rectangular cross sectional view) like drawing 5 (a), a tangent L1 and a straight line L2 will be in agreement. Next, when the gas introduction side S of the second side claw-like part six a3 consists of single curved surfaces (curve with a circle single on an axial rectangular cross sectional view etc.), such as a surface-of-a-sphere arc, like drawing 5 (b), a straight line L2 serves as a form opened to a radial-direction outside rather than a tangent L1.

[0047] Also when [furthermore,] the gas introduction side S of the second side claw-like part six a3 consists of two or more plane (two or more straight lines [top / axial / rectangular cross sectional view]) or two or more curved surfaces (two or more curves [top / axial / rectangular cross sectional view]) to which it bends to a radial-direction inner side as a tip like drawing 5 (c) A straight line L2 serves as a form opened to a radial-direction outside rather than a tangent L1. However, the gas introduction side S of the second side claw-like part six a3 may be constituted from two or more plane or two or more curved surfaces to which only a tip part bends rapidly to a radial-direction inner side by the form of the cutter which creates the second side break six a2 etc. like drawing 5 (d). In such a case, it sets, and if WD

(s), such as waterdrop, an oil droplet, etc. on the gas introduction side S of the second side claw-like part six a3, are in the situation where the extension top of the gas introduction side S which has ridden with the exhaust gas EG now is blown away, it is not necessary to take into consideration tip bending part 6a3' as a gas introduction side S.

[0048] moreover, when the gas introduction side S of the second side claw-like part six a3 consists of two or more plane (two or more straight lines [top / axial / rectangular cross sectional view]) or two or more curved surfaces (two or more curves [top / axial / rectangular cross sectional view]) to which it bends on the radial-direction outside from the middle as a tip like drawing 5 (e) A tangent L1 serves as a form opened to a radial-direction outside rather than a straight line L2. However, the gas introduction side S of the second side claw-like part six a3 may be constituted from two or more plane or two or more curved surfaces which only a tip part bends rapidly on the radial-direction outside, or project as Bali by the form of the cutter which creates the second side break six a2 etc. like drawing 5 (f). In such a case, it sets, and if WD(s), such as waterdrop, an oil droplet, etc. on the gas introduction side S of the second side claw-like part six a3, are in the situation where the extension top of the gas introduction side S which has ridden with the exhaust gas EG now is blown away, it is not necessary to take into consideration tip bending part or Bali partial 6a3" as a gas introduction side S.

[0049] Although drawing 5 explains the form of a guide object (the second side claw-like part six a3) above, the actual second side claw-like part six a3 may assume still more complicated form, and the side wall outside side La of the second tubed part 6a may not be a perfect circle. Especially The tip P1 (henceforth a tip P1) and/of the gas introduction side S of the second side claw-like part six a3 Or when it is hard to define the point P2 (henceforth a point of contact P2) that the base of the gas introduction side S of the second side claw-like part six a3 touches the side wall outside side La of the second tubed part 6a, the case where a tangent L1 and a straight line L2 stop being over is also assumed. So, when such, it can ask for a tip P1 and a point of contact P2 by circle approximation described below, for example.

[0050] The search circle C most approximated to the side wall outside side La of the second tubed part 6a in drawing 11 (for example, [the circumscribed circle of the side wall outside side La can be selected, and]) a search circle center -- O and a search circle radius -- R -- carrying out -- it can draw and can be determined as a point of contact P2 with 98% of the search circle radius R in an approach position with the base of this side wall outside side La and the gas introduction side S on the gas introduction side S. On the other hand, when Bali partial 6a3" is projected and formed at the tip of the second side claw-like part six a3 towards the radial-direction outside, the base of Bali partial 6a3" and a bonding link with the gas introduction side S can be determined as a tip P1. Therefore, the straight line L2 which connects the tangent L1 passing through a tip P1, and a tip P1 and a point of contact P2 is called for, respectively.

[0051] The modification of a protector 6 is explained hereafter. In addition, the same mark is given to the portion which is common in the work example of drawing 3 , and explanation is omitted.

[0052] First, drawing 6 shows the first modification of the protector 6. In the work example of drawing 6 , the eight-piece second side gas inlet 63 is formed in the direction of a circumference by abbreviation regular intervals at the side wall part of the second tubed part 6a. The gas introduction side S of the second side claw-like part six a3 formed in gas inlet 63 the each second side is that which has flat form compared with the work example of drawing 3 (however, it consists of loose curved surfaces instead of

a plane). Gas leading in wire L is further estranged and located in a radial-direction outside rather than drawing 3 to the side wall outside side Lb of the first tubed part 6b. Therefore, the centrifugal force generated in connection with a revolution style becomes larger, and waterdrop, an oil droplet, etc. are separated quickly, and it becomes much more difficult to condense moisture in gas EG under test on the side wall outside surface of the first tubed part 6b. In addition, since the group 61 of the hole by the side of the front is omitted among the first side gas inlets in the work example of drawing 6 , there is no flow of the gas EG under test which flows into the inside of the first tubed part 6b from the group 61 of this hole.

[0053] Next, drawing 7 shows the second modification of the protector 6. Since the second side gas inlet 63 is formed in the position of axial direction front end slippage in the work example of drawing 7 rather than the front end which is 6t of diameter reduction parts of the first tubed part 6b The first tubed part 6b (6t of diameter reduction parts) corresponding to the second side gas inlet 63 stops existing in the axial rectangular cross section including the second side gas inlet 63 expressed with drawing 7 (b). Then, the second side claw-like part six a3 is greatly bent to a radial-direction inner side rather than the work example of drawing 3 , and it can set up so that gas leading in wire L may pass along the neighborhood of an axial center of a protector 6. As a result, the opening width of the second side gas inlet 63 becomes large, and the exchange speed (turn volume) of gas EG under test increases.

[0054] Moreover, some modifications of others of a protector 6 are shown in drawing 8 and drawing 9 . In addition, the same mark is given to the portion which is common in the work example of drawing 3 , and explanation is omitted.

[0055] In the protector 6 of drawing 8 (a), 63a2 rows of the second side gas inlets are formed with 63b in the position corresponding to 6t of diameter reduction parts. The flow of the gas in alignment with the external surface of 6t of diameter reduction parts becomes smooth by this, and a response is improved, and also it becomes difficult to receive the influence by the direction of a gas stream. In addition, in drawing 8 (a), the front end side of the first tubed part 6b is made into small diameter by 6h of steps of the direction of a circumference, and Crevice G is formed between the second tubed part 6a by it. Moreover, the back end part of the first tubed part 6b is inserted in the small diameter part 3b of the subject metal fittings 3. And the back end part of the second tubed part 6a is inserted in in the form put on the outside, and is being fixed to the small diameter part 3b by the weld zone which is not illustrated with the first tubed part 6b in this overlap part.

[0056] In drawing 8 (b), it has 3-fold structure which formed the third tubed part 6c with the wrap form in the first side gas inlet 60 (one row is formed in the back end side) between the first tubed part 6b and the second tubed part 6a. Thereby, invasion of the waterdrop inside the first tubed part 6b, oil, or dirt becomes much more difficult to take place.

[0057] Moreover, at drawing 8 (c), the third tubed part 6c is arranged with the form in which the second side gas inlet 63 does not cover the back end side with a wrap on the outside of the second tubed part 6a. Thereby, when a gas flow rate goes abruptly up, the temperature fall of a primary detecting element D is prevented still more effectively. Furthermore, in drawing 8 (d), the third tubed part 6c is extended to the position of the second side gas inlet 63, and the third side gas inlet 66 is formed in a corresponding position. Thereby, invasion of the waterdrop inside the first tubed part 6b, oil, or dirt becomes much more difficult to take place.

[0058] Drawing 8 (e) is the form which projects for inner along the periphery of the second side gas inlet 63 from the side wall circles side of the second tubed part 6a, and shows the example in which the air current guide 6w (guide object) was formed. The revolution style which introduces the exhaust gas EG between the first tubed part 6b and the second tubed part 6a, and turns around 6t of diameter reduction parts by this can be generated, the flow of the exhaust gas EG within a protector 6 becomes difficult to be confused, and the response of a sensor 1 becomes much more difficult to be influenced by the direction of the exhaust gas style EG.
[0059] Drawing 8 (f) is the example which formed the diameter reduction part 6u also in the front end side of the second tubed part 6a. The suction effect of the gas which flowed in the protector 6 is heightened by this, and the response of a sensor 1 becomes much more difficult to be influenced by the direction of the exhaust gas style EG.
[0060] Moreover, as shown in drawing 9 (g), you may form the still more cylindrical straight line part 6v in the front end side of 6t of diameter reduction parts of the first tubed part 6b. On the other hand, the second tubed part 6a may form an axial section in the shape of a polygon, as shown in drawing 9 (h).
[0061] moreover, it is shown in drawing 9 (i) and (j) -- as -- the first tubed part 6b -- the external surface -- it is almost good also considering the whole as 6t of diameter reduction parts. In addition, like drawing 9 (i), the section may serve as abbreviation straight shape (the outside form which is 6t of diameter reduction parts becomes a truncated cone form thing in this case), and 6t of diameter reduction parts may serve as the shape of a curved surface which projects outward (the outside form of 6t of diameter reduction parts will become spindle-shaped in this case) like drawing 9 (j). Furthermore, you may make it make the front end side of 6t of diameter reduction parts of the first tubed part 6b project from 6f of bottoms of the second tubed part 6a like drawing 9 (k). In this case, the second side gas outlet 64 is annularly formed between the external surface of 6t of diameter reduction parts, and the opening common-law marriage of 6f of bottoms.
[0062] Furthermore, in the work example of drawing 9 (l), the diameter of a tip outside of the first tubed part 6b is formed in 6s of main part part outer diameter, and the diameter of said. Moreover, the first side gas inlet consists of groups 60, 61a, and 61b of the hole of three rows, among these the thing by the side of back (60) is arranged with the form which counters a primary detecting element D. And the group of the hole by the side of the front consists of what is arranged with the form which counters the second side gas inlet 63 (61a), and a thing (61b) arranged in the intermediate part of the group (60) of the two above-mentioned holes, and (61a).
[0063] In addition, in the modification of drawing 8 (a), among the two-row second side gas inlets 63a and 63b, desirably, although the above-mentioned second side break six a2 and the second side claw-like part six a3 (guide object) were formed in both like drawing 3 , at least on the other hand, illustration was omitted approximately. Moreover, also in each modification of drawing 8 (b) - drawing 8 (d), drawing 8 (f), drawing 9 (g) and drawing 9 (i) - drawing 9 (k), although the second side break six a2 and the second side claw-like part six a3 (guide object) were formed in the second side gas inlet 63 like drawing 3 , all omitted illustration.
[0064] The structure of the sensor of this invention explained above is applicable like gas sensors, for example, HC sensor, NOx sensors, etc. other than an oxygen sensor.

[Brief Description of the Drawings]
[Drawing 1] The front view and longitudinal section of an oxygen sensor showing an example of the gas sensor of this invention.
[Drawing 2] The explanatory view showing the structure of the ceramic device as the detection element.
[Drawing 3] The fragmentary longitudinal cross-section, X-X axis sectional view, and Y-Y axis sectional view showing the details of the structure of the protector of drawing 1 .
[Drawing 4] The expansion explanatory view of drawing 3 (b) showing an operation of a guide object.
[Drawing 5] The explanatory view showing the form of a guide object.
[Drawing 6] The fragmentary longitudinal cross-section, X-X axis sectional view, and Y-Y axis sectional view showing the first modification of a protector.
[Drawing 7] The fragmentary longitudinal cross-section, X-X axis sectional view, and Y-Y axis sectional view showing the second modification of a protector.
[Drawing 8] The longitudinal section showing some other modifications of a protector.
[Drawing 9] The longitudinal section ((e) - (g) and (i) - (l)) and the axial sectional view ((h)) showing some another modifications of a protector.
[Drawing 10] The sectional view showing the structure of the conventional protector.
[Drawing 11] The explanatory view which illustrates the method of asking for the tip P1 and point of contact P2 by circle approximation.
[Explanations of letters or numerals]
1 Oxygen Sensor (Gas Sensor)
2 Ceramic Device (Detection Element)
D Primary detecting element
6 Protector
6a The second tubed part
Six a2 The second side break (break)
Six a3 The second side claw-like part (claw-like part; guide object)
6b The first tubed part
Six b2 The first side break
Six b3 The first side claw-like part
6s Main part part
6t Diameter reduction part
60, 61, 61a, 61b The first side gas inlet
62 First Side Gas Outlet
63, 63a, 63b The second side gas inlet
64 Second Side Gas Outlet
EG Exhaust gas (gas under test)
S Gas introduction side
L Gas leading in wire
L1 Tangent in the tip of the gas introduction side of a guide object
L2 Straight line which connects the point that the base of the gas introduction side of a guide object touches the side wall outside side of the second tubed part, and the tip of a gas introduction side

La Side wall outside side of the second tubed part
Lb Side wall outside side of the first tubed part
P1 Tip of the gas introduction side of a guide object
P2 Point that the base of the gas introduction side of a guide object touches the side wall outside side of the second tubed part

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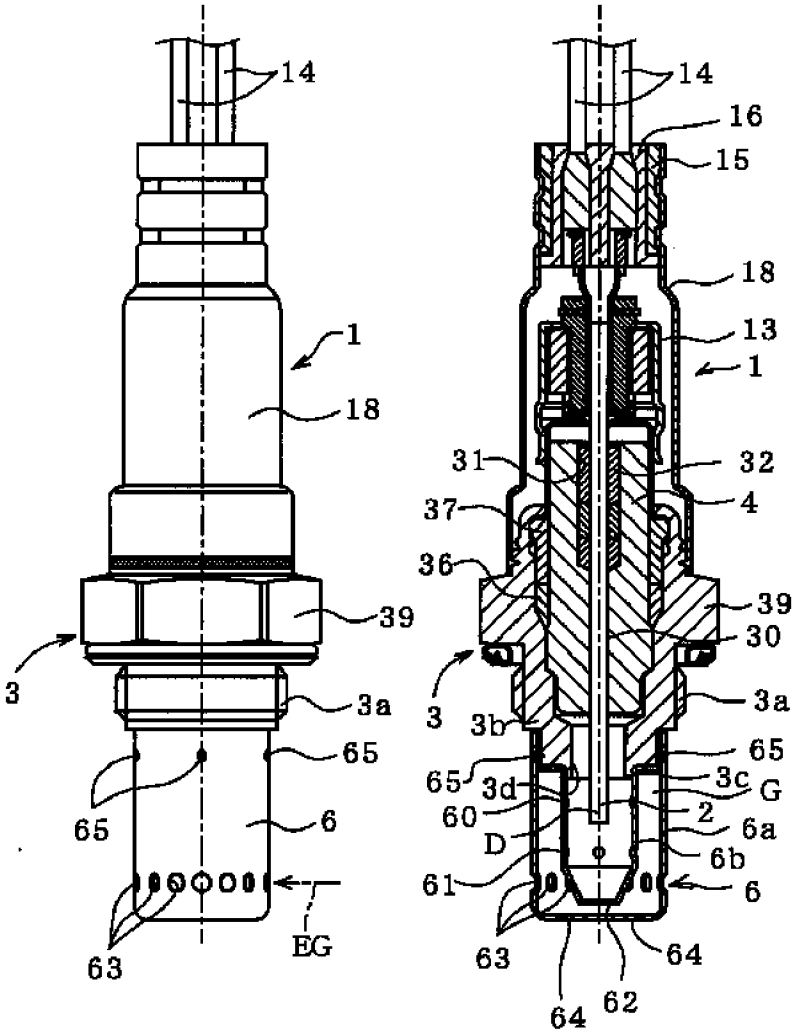
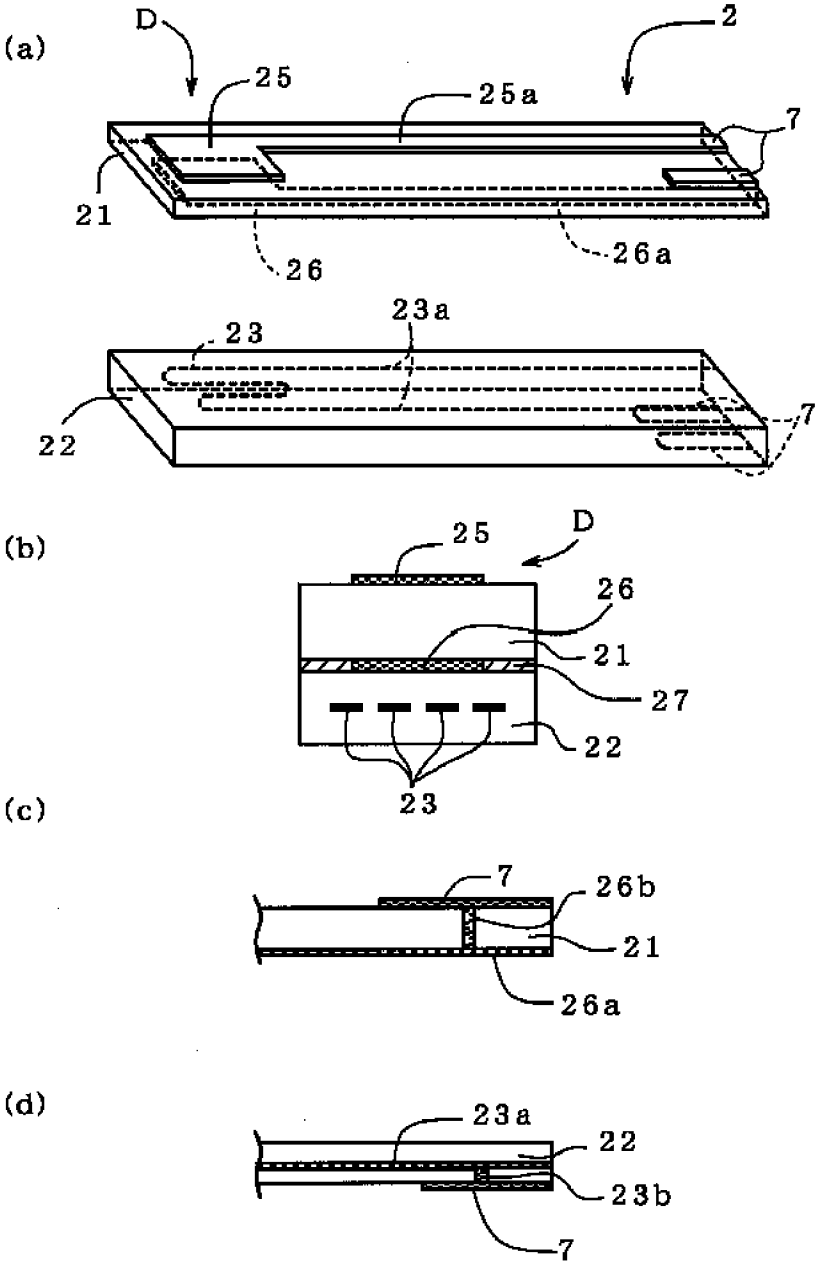
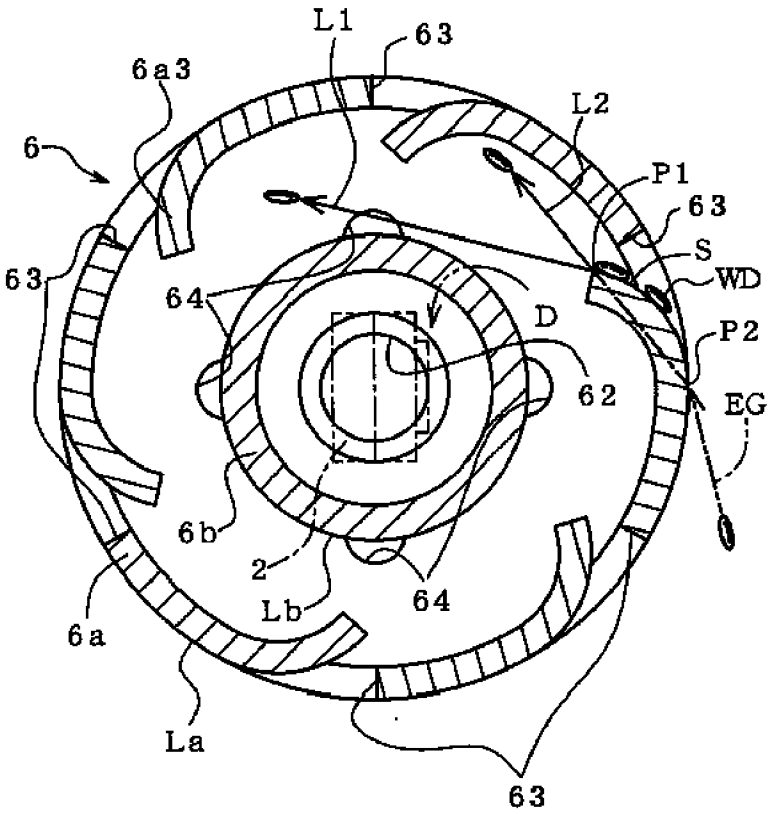
[Drawing 1]



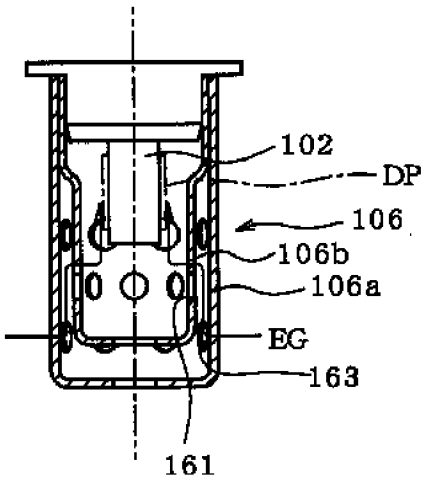
[Drawing 2]


(a)
D
2
25
25a
7
21
26
26a
23a
23
22
7
(b)
25
D
26
21
27
22
23
(c)
7
26b
21
26a
(d)
23a
22
23b
7

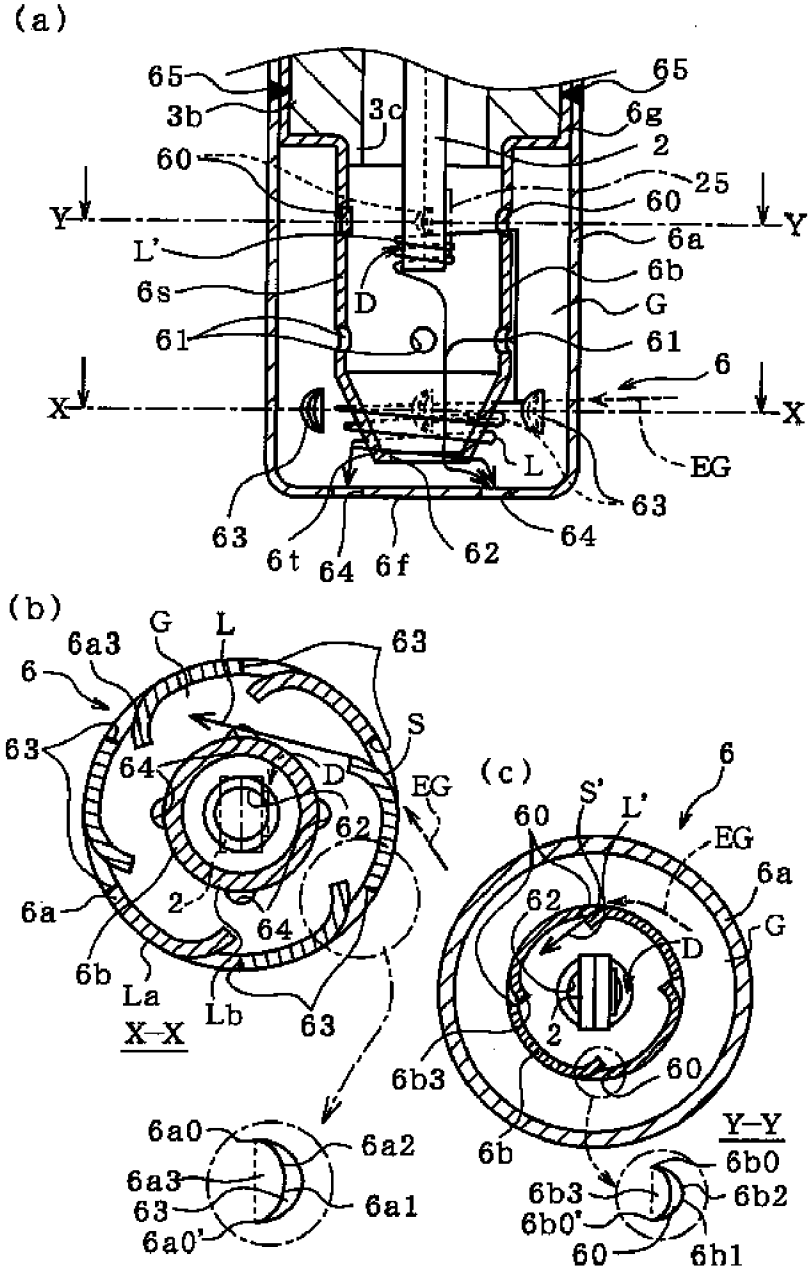
[Drawing 4]



[Drawing 10]



[Drawing 3]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65
3b
3c
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Y
L'
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63
6t
64
6f
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64
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6b
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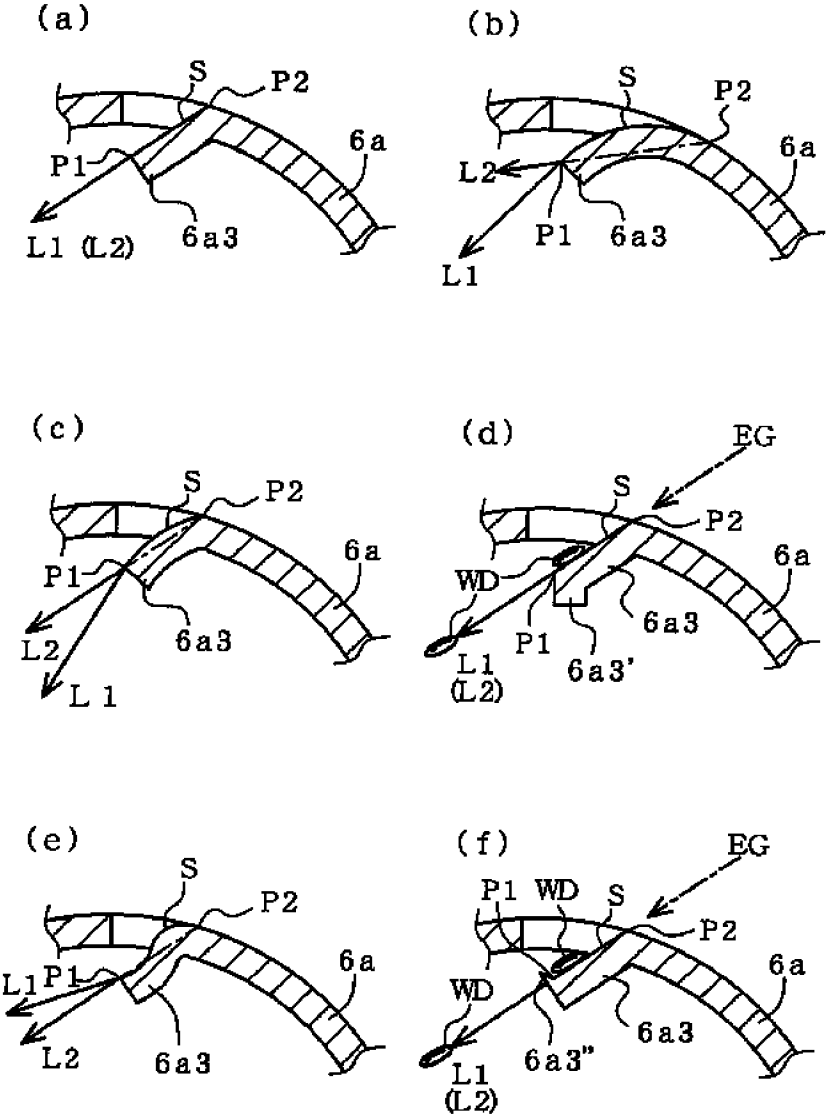
6a0'

[Drawing 5]


(a)
S
P2
6a
P1
L1 (L2)
6a3
(b)
S
P2
6a
L2
P1
6a3
L1
(c)
S
P2
6a
P1
6a3
L2
L 1
(d)
EG
S
P2
6a
WD
6a3
P1
L1
(L2)
6a3'
(e)
S
P2
6a
L1
P1
L2
6a3
(f)
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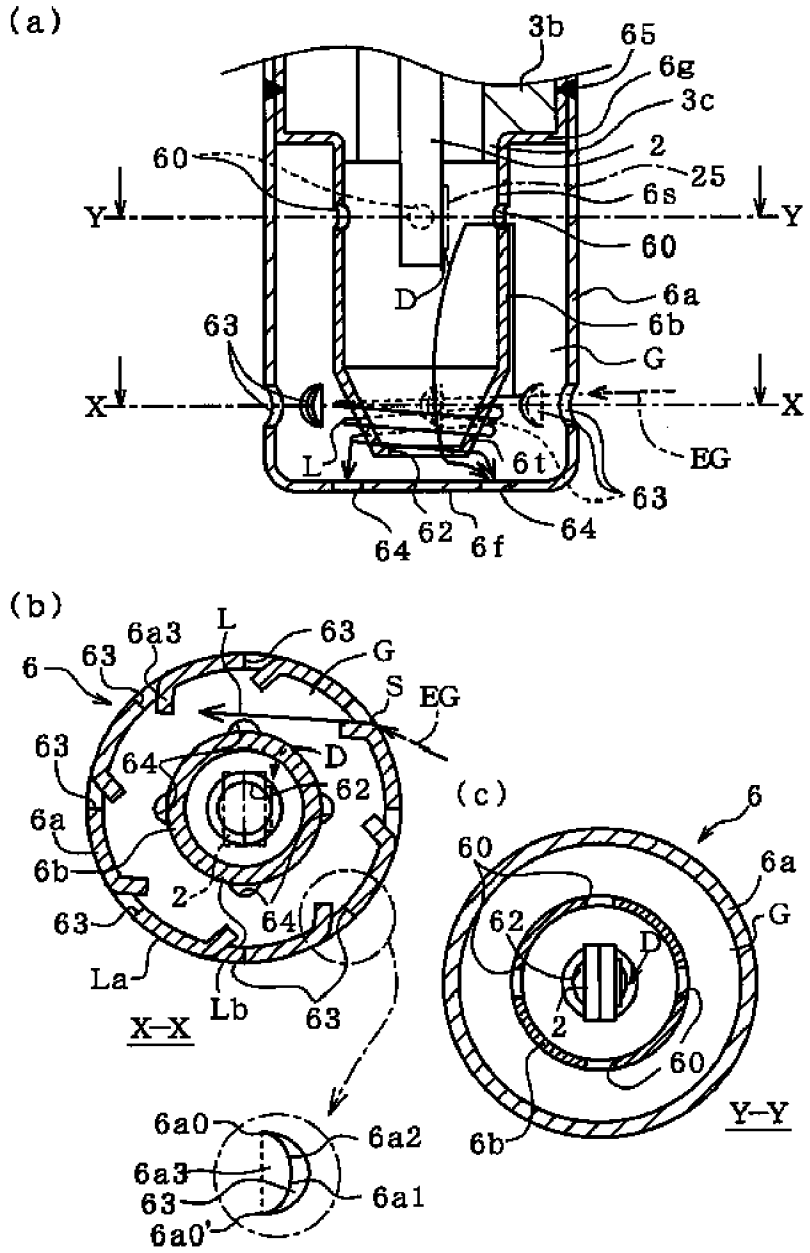
WD
S
P2
6a
WD
6a3
L1
(L2)
6a3"

[Drawing 6]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6g
3c
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6s
60
Y
Y
60
D
6a
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EG
L
6t
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64
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6f
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(b)
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63
G
6
63
S
EG
63
64
D
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6a
6b
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Lb
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(c)
6
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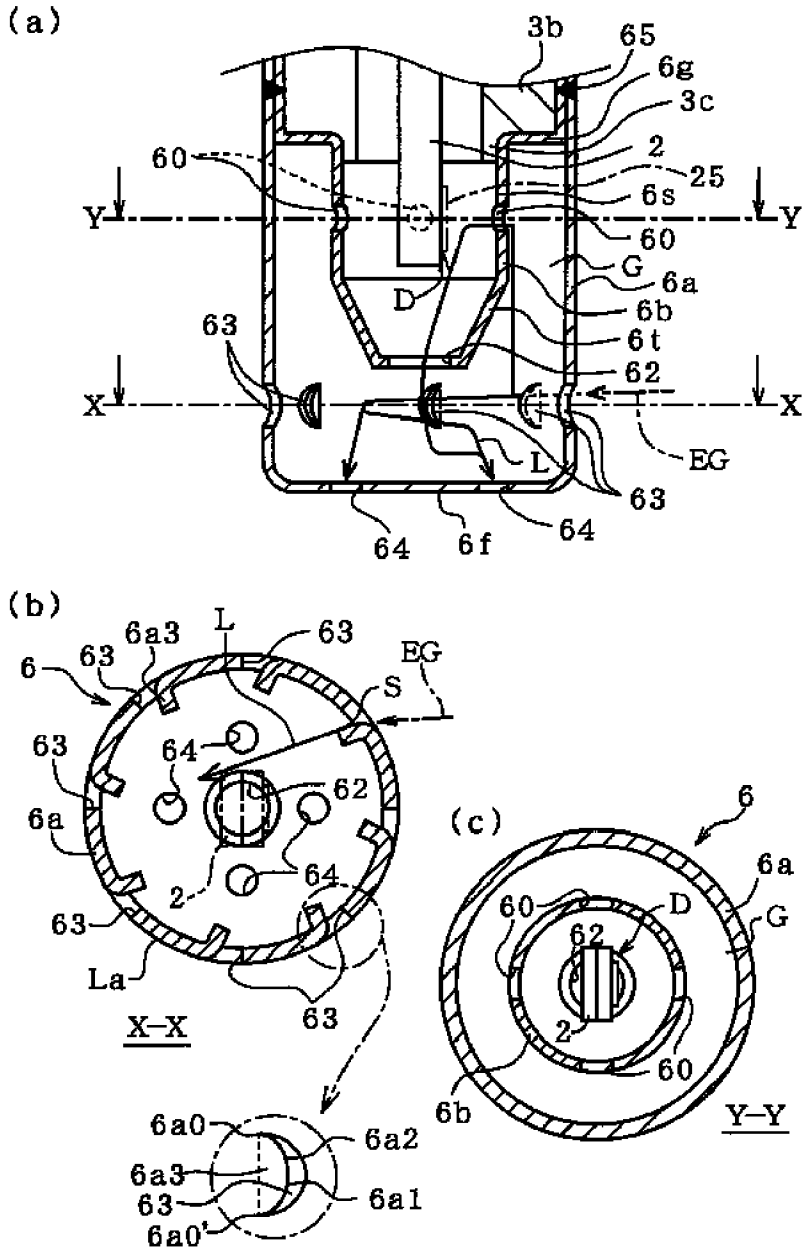
6a2
6a3
63
6a1
6a0'

[Drawing 7]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6g
3c
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6s
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G
6a
6b
6t
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EG
63
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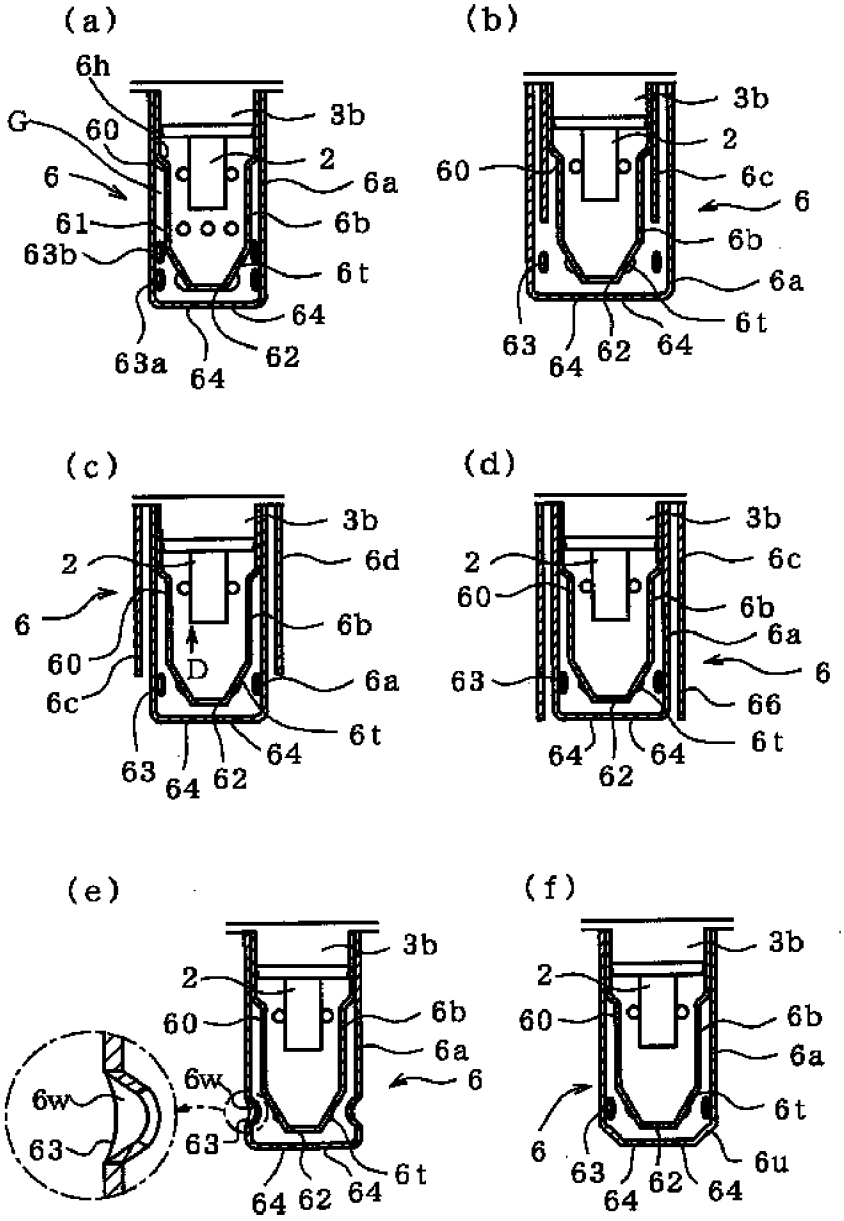
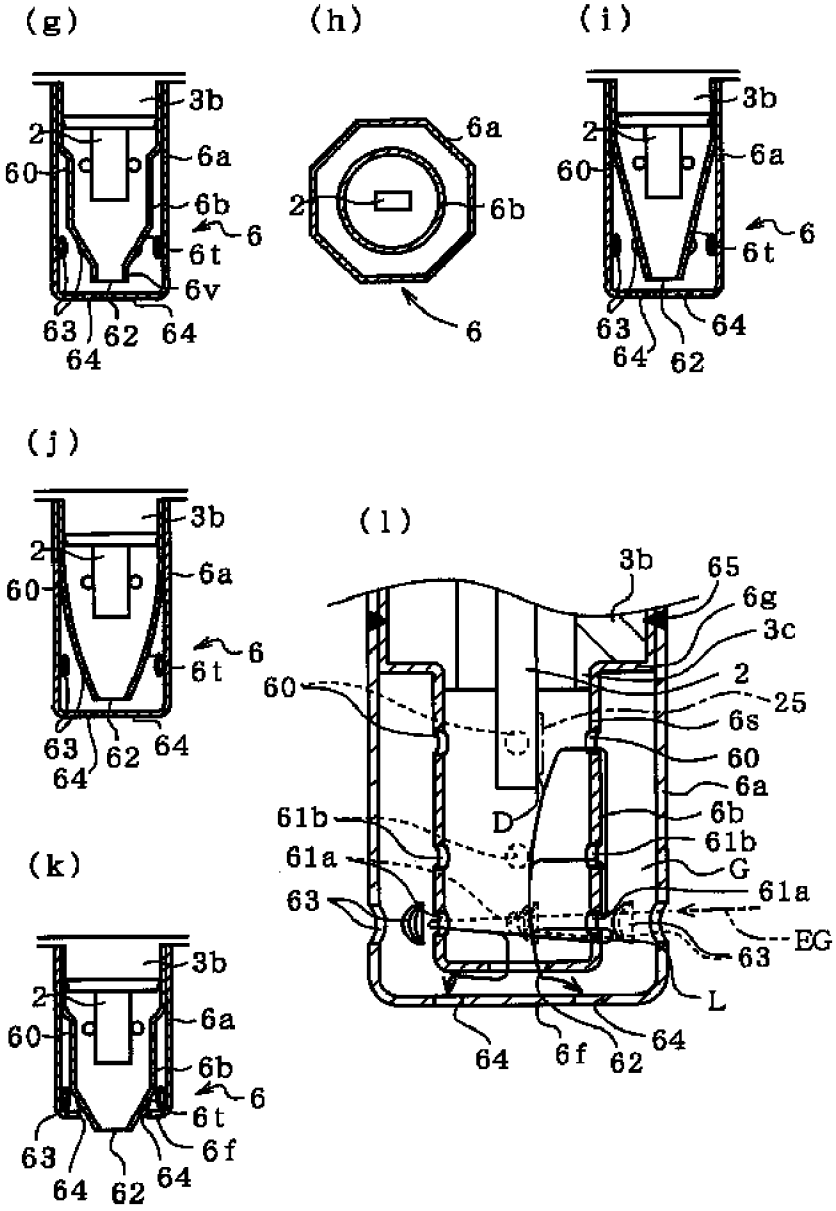
64
63
L
D
60
Y
Y
X
X
(b)
6a3
L
63
EG
6
63
S
63
64
62
6a
64
2
63
La
63
X–X
(c)
6
6a
G
60
D
62
2
60
6b
Y–Y
6a0
6a2
6a3
63
6a1
6a0'

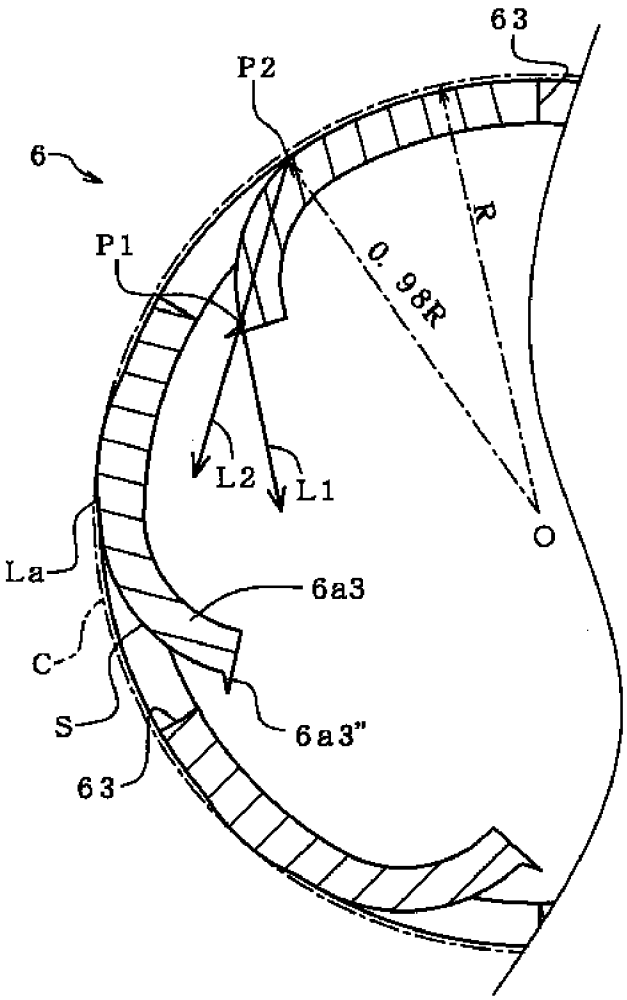
[Drawing 8]


(a)
6h
G
60
3b
2
6
6a
61
6b
63b
6t
64
63a
64
62
(b)
3b
2
60
6c
6
6b
6a
6t
63
64
62
64
(c)
3b
2
6d
6
6b
60
D
6c
6a
6t
63
64
62
64
(d)
3b
2
6c
60
6b
6a
6
63
66
6t
64
62
64
(e)
3b
2
60
6b
6a
6
6w
6w
63
63
6t
64
62
64
(f)
3b
2
60
6b
6a
6t
6
63
64
62
6u
64

[Drawing 9]


(g)
3b
2
6a
60
6b
6
6t
6v
63
62
64
64
(h)
6a
2
6b
6
(i)
3b
2
6a
60
6
6t
63
64
64
62
(j)
3b
2
6a
60
6
6t
63
62
64
64
(k)
3b
2
6a
60
6b
6
6t
6f
63
64
62
64
(l)
3b
65
6g
3c
2
25
60
6s
60
6a
61b
D
6b
61b
61a
G
63
61a
EG
63
L
64
6f
62
64

[Drawing 11]



[Translation done.]